Addis Ababa University
College of Natural and Computational Sciences

Role of Community in Conservation of Woody Plant Species in Community Based Forests at Raya Alamata District, Northern Ethiopia

Asmelash Yalew Beyene

A Thesis Presented to the Department of Zoological Sciences Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Biology

August, 2019

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Approval sheet I

This is to Certify That the Thesis Prepared **by Asmelash Yalew Beyene** under the Title: **Role of Community in Conservation of Woody Plant Species in Community Based Forests Located at Raya Alamata District, Northern Ethiopia** And Submitted in Partial Fulfillments of the Requirements for the Degree of Masters of Science (M.Sc) in Biology Compiles with Regulation of the University and Meets the Accepted Standards with Respect to Originality and Quality.

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Abstract

Role of Community in Conservation of Woody Plant Species in Community Based Forests Located at Raya Alamata District, Northern Ethiopia

Asmelash Yalew Beyene

Addis Ababa University, 2019

Globally it is crystal fact that community plays an important role in conserving the available natural resources in their environment. This is also common throughout Africa. So, Ethiopia is as one of the Sub-Saharan African country as well. Evaluate the role of communities living in and around Raya Alamata in woody plant species conservation in the community based forests of the district.

Purposive sampling method was used to select *Kebeles* with communal forests and free grazing land adjacent to each other. A systematic random sampling method was used to locate the sample plots in order to generate the woody plant species inventory data, that could help to investigate species composition, diversity, abundance, dominance, similarity and population structure. The species area curves were drawing following with the x-axis representing each additional sample area, and the y-axis representing the number of species. The vegetation in the communal forest as compared to that of the grazing land has shown an increased and change in species composition with increased of woody species and grass. Comparing the diversity of woody plants species, all the three communal forests are significantly different ($p<0.01$) from the free grazing lands.

The Pearson test reveals that the educational level, age, sex, wealth, position and occupation of the respondents attitude and perception towards the communal forest are not significant at ($p<0.05$).Generally, the vegetation composition of woody species was much denser in the communal forests than the free grazing lands. This indicated that the local institutions have played a role in conserving biodiversity of woody species.

Key words/ Phrases: communal forest, free grazing land, local institution and woody plant species

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My friend, YirgaTamene, is also highly acknowledged for his sincere cooperation to share his experience in organizing data and editing the thesis.

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List of acronyms

BSP = Bio diversity Support Program

CPR = Common Property Resource

EFAP = Ethiopian Forest Action program

FAO = Food and Agricultural Organization

^{0}E = Degree East

IVI = Importance Value Index

IPMS = Improving productivity and Market Success

ILRI = International Livestock Research Institution

SSA = Sub-Saharan Africa

TLU = Total Livestock Unit

TARI = Tigray Agriculture Research Institution

Chapter one

1 Introduction

1.1 Background of the study

Globally it is crystal fact that community plays an important role in conserving the available natural resources in their environment. This is also a common human role throughout Africa though; it varies from place to place and from community to community. Therefore, Ethiopia, as one of the Sub-Saharan Africa country, it is known for its fast population growth environmental degradation and structural food insecurity (Tesfaye, 2003). Among others, accelerated forest resources degradation has become the major threat to rural livelihoods and sustainable natural resource management in the country. Other factors such as intensive cultivation, over grazing, deforestation, soil erosion, low soil fertility, water scarcity, livestock feeds and unwise use of fuel wood etc. also play a great role in forest resources degradation. These factors often interact with one another resulting in or are-enforcing "cycle of poverty that is indicated as deep and structural food insecurity and natural resources degradation trap" (Alemneh, 2003).

Scholars and practitioners often assert the need for local level institutions in natural resources management schemes (Ostrom, 1990, Bromley *et al.,* 1992). The variation of local institutions discovered was discourages the view that template forest policies was likely to work when imposed on a country as a whole. As a matter of fact, the long history of human settlement together with the increasing demands of the growing human and animal population make the natural environment excessively exploited. These un desirable human activities on the un wise and excessive use of natural resources such as cutting trees and bushes for crop cultivation, grazing, use of fire wood and timber have resulted in reduced protective plant cover there by soil erosion induced land degradation in Tigray as reported by (REST, 2004). These problems associated with soil moisture stress have played significant role in reducing agricultural productivity and resulted in substantially large populations facing poverty and food insecurity in the region because of there is deforestation, drought and soil erosion will be also consequences. Though there is little documentation that shows communities traditional resource management practices in Ethiopia, it is clear that a number of communities had traditional resource management practices including some element of bio-diversity

conservation (EFAP, 1994 cited in Domoz, 2007).This is evident that a local community of the study area do have local legitimacy of managing their communal forest.

In addition, since local communities live with forests, they are the primary users of forest products. So, they create their own local rules that significantly affect the conditions of their inclusion in forestry management schemes which are now being considered essential by many researchers and policy makers (Arnold, 1992). The present study aimed at assessing the role of the community living in and around Raya Alamata district in conserving woody plant species available in the study area are practices like constructing local rules, selecting leaders, conflict resolutions, sanctions and local legitimacy.

1.2 Statement of the problem

A number of bilateral and multi-lateral projects have tried to introduce new organizational structures and regulations for resource protection which they have not always been able to sustain (Yohhanes, 2007). This might be due to lack of local people participation who may contribute to such conservation efforts. Few documents are available regarding local institutions and organizations that work on resource management. However, effort to conserve natural resources is still continued particularly at local level. In Raya Alamata, there are some communally managed forests which are protected and managed by the initiation of the local communities. Understanding the importance of biodiversity, those local communities design their own local rules and regulations to manage the forests. So, this study aimed at assessing the strategies of local indigenous forest management institutions and documenting the roles of local community in plant species

1.3 Research questions

1. What is the attitude and perception of the local community towards the benefits of woody plant species?
2. What is the role of community in conserving woody plant species which is governed by local forest management institutions
3. What is the regeneration status of the managed communal forests as compared to those openly grazed sites?
4. How was the local forest management institutions arranged to conserve woody plant species?

1.4 Objectives of the study

1.4.1 General Objective

To evaluate the role of communities living in and around Raya Alamata in woody plant species conservation in the community based forests of the district.

1.4.2 Specific Objectives

1. To investigates the effectiveness of the existing local communal forest management institutions established by the communities in the study area.

2. To compare the state of managed communal forests with free grazing lands in terms of abundance, species richness, IVI and diversity of woody plant species.

3. To assesses local community's perceptions about the potential socio-economic and environmental benefits of woody plant species.

Chapter two

2 Review of related literature

2.1 Managing forests as common property

Common property can be defined as corporate group property (Bromley, 1992). Common property has often been used to refer both to land or resources available to all and consequently not owned or managed by anyone and to situations where access is limited to a specific group that holds rights in common. In case of open access to common resources, there is unrestricted entry and unregulated use of resources. Because everyone prioresses his own benefits. This has often caused an overexploitation and degradation of common resources, a situation often referred to as the "tragedy of commons" (Hardin, 1968).

Common resources which are the concern of the study like woody plants present in communal forests are degraded because each individual gains by increasing their use level as long as marginal benefit are less than average cost, in the absence of specified ownership they cannot be valued in the market and competing individuals can not cooperate management scheme that would benefit all in common.

Nearly everywhere common property resources have been massively reduced in modern times. Privatization, encroachment and government appropriation have been main processes taking resources out of common use. Increasing pressure on what's left is frequently led to its progressive degradation. In order to regulate the use and management of a common pool forest resource, there must be institutions that authorize and secure use by a particular group of users (to the exclusion of others), and institutions that set rules to given this use, monitor and enforce these rules. Thus, common property system can function only if the group is organized, or can organize itself, to set and implement such rules, provide individual members with inputs and services that are more effective when organized collectively, and provide a mechanism for negotiation and liaison with the state and other external entries (FAO, 1998). The choice of property regime may also reflect historical and conquest institutions (Brune, 1998).

Despite these negative pressures and trends people still widely depend on common property resources, with the poor usually more heavily dependent than others. Even in the heavily reduced and degraded dry land communal areas of India, it was found that the poor obtained

the bulk of their fodder and fuel wood, and from 14% to 23% of their income, from common property resources (FAO, 1998).

2.2 Woody plant species of Biodiversity

Biodiversity is defined as time variety of life and its process (Noss and Cooperrider, 1994; Tadesse Woldemariam, (1998). It is the totality of genes, species and ecosystems and human culture that is closely linked to the entire process of totality. There levels of diversity can be recognized: Genetic diversity (Variation of genes within species), species diversity (variety of species within a given bioregion) and ecosystem diversity (refers to the boundary of biological communities in association with species and ecological system). According to this definition, biodiversity includes the variety of living organisms, the genetic diversity, the community and ecosystem in which they occur and the ecological and evolutionary process in which it helps them to keep functioning. Diversity helps in the functioning of ecosystems and interaction between ecosystems. Reduction of diversity will result in the instability of ecosystems. The loss of a certain fraction will result in the disruption of the whole system (BSP, 1993).

Biodiversity conservation could help in the future realization on the potential values of species. The unknown potential of genes and ecosystems remains a never-ending source of biological resources of inestimable value. Wild species will be of great importance for the further advancement of agriculture, animal husbandry, medicine, industry, etc. they have a security value, option value, economic value, and cultural value if biodiversity is not conserved, species, which have a great importance for human kind, will become extinct.

Diversity of biological resources and ecological systems, including human culture is shrinking. Forests are reservoirs of biological diversity and have a great variety of exploitable plant species for timber and non-timber forest product. The main causes of loss of biological diversity are unwise human interaction with environment, human population growth, and change in natural conditions and homogenization of views.

The strategies to conserve biodiversity are in situ conservation, reduction of deforestation ex situ conservation using gene banks, botanical gardens, arboreta, planted forests and agro forestry systems. Other strategies includes integrated land use and conservation, monitoring utilization and generating information on the status of overexploited species, raising public awareness especially at community level and harmonization of laws related to land use. In

addition the ownership or tenure of forested land has a potentially important impact on the like hood of sustainable management and the conservation of biodiversity.

2.3 Indigenous knowledge and biodiversity conservation

Indigenous knowledge has been defined as a body of knowledge built up by a group of people through generations of living in close contact with nature (Johnson, 1992). It includes a system of self-management that governs resources use. The study of indigenous forest management is often considered to belong to the domain of research on indigenous knowledge systems. Knowledge systems are concerned about the way people understand the world, interpret and apply meaning to their experiences. Such knowledge is built through the complex process of selecting, rejecting creating, and transforming information and is in extricable linked to the social, environmental and institutional contexts in which it occurs (Arce and long, 1992).

2.3.1 Indigenous forest management institutions

According to Watson (2003), indigenous institutions are institutions that emerge in a particular situation that are practiced or constituted by people who have had a degree of continuity of living in and using resource of an area. Indigenous institutions represent established local systems of authority and other phenomena derived from the socio-cultural and historical processes of a given society. They originate from local cultures; have firm roots in the past and are variously referred to as informal, pre-existing native institutions.

Diffusion of traditional organizations often becomes major factor contributing to the declined strength of village-level organizations on common-property resource (CPR) management and allocation. (Baland and Pleatuea, 1996)Upoff and Largholz (1998) indicated that social norms and conventions that have often been seen to govern CPR have saved forest from degradation.

2.4 Factors affecting common property forest management

During the past decade, considerable progress has been made with the design of analytical models that help us understand what factors and interactions determined the circumstances under which common property management is likely to be appropriate and successful, and under which it is not (Bromley and Cernea, 1989;NAS, 1986; Oakerson, 1986; Ostrom, 1990; Wade, 1988 cited in FAO, 1993). Key features that have emerged from these analytical models are summarized as below.

A basic physical and technical characteristic of the resource is whether the resource has definable boundaries and can be protected. Management of a CPR is more likely to be effective if the resource is close to the group and can be readily monitored. Another basic consideration is whether the resource can be divided up or not. An area of forest can produce multiple products as long as its multispecies structure is maintained.

The incentive for users to invest in collective management is likely to be greater if the resource is capable of meeting a substantial part of users' needs and if these benefits can be obtained rapidly and regularly. Therefore, the tendency to allocate degraded forest or scrubland for collective management in many programs has probably often weakened the incentive for users to participate. The same is true if the resource allocated is too small to meet many of the user's needs. Resources that produce outputs that are valued locally, and products that members of the user group can benefit from in an equitable manner, are also likely to provide a stronger incentive to common property management than others that do not.

2.4.1 Characteristics of users group

It has been widely argued that small homogeneous groups, confined to those with similar views on the use of the resource, are more likely to be successful than larger, more diverse groups. There are many instances where smaller groups do seem better able to sustain common property regimes. Although the task of dividing responsibilities and benefits may favors small and cohesive user groups, the task of a managing and exercising control over the resource may call for a large body that encompasses all those with a claim on the resource. Migration, mobility and market integration can all affect the stability of the community, and lack of stability can undermine the possibility of voluntary collaboration. Education or exposure to knowledge and ideas from elsewhere may alter members' perceptions of what they want from the CPR or from collective action. Changing attitudes and increasing wealth may introduce opportunities to benefit from privatization, or introduce the danger that the user group will become dominated or usurped by emergent elite within the broader community. As communities change in these ways, the composition of a user group and its objectives are likely to need to change as well.

2.4.2 Characteristic of institutional arrangements

The institutional characteristic that affects the success of communal forest management which is explained by Ostrom (1990) is presented in (Table1)

Table 1: institutional characteristics for successful communal group forest management: Source (Ostrom, 1990).

No	Characteristics	Explanation
1	Clearly defined boundary and users	Individual or house holders who have rights to explore resources must be clearly identified. The boundaries of the area managed must also be clearly defined and agreed up on.
2	Appropriate rules for exploiting the resources and maintaining	Rules limiting the time place and technology used must be appropriate to the particular resources and linked to investment in the maintenance of the resource. Rules are simple and easily understood.
3	Collective choice arrangement	The people affected by the rules must be able to participate in changing them
4	Effective monitoring produces	Monitors of the rules are either users of the resources or accountable to them monitoring must easily to carry out.
5	Graduated sanctions	Users of the resources who violate rules are likely to face graduated sanctions are assessed and imposed by follow users or officials accountable to them
6	Conflict resolution mechanism	Users and their officials have rapid access to low cost mechanisms to resolve conflicts among users and officials
7	Recognition of legitimacy	The rights of users to devise their own institutions are not challenged by external authorities in most cases they need to be actively supported by them.

2.5 Values of Biodiversity conservation

People value biological resources in different ways: spiritually, economically, aesthetically, culturally, and scientifically. Biodiversity values also differ at the international, national, and local biological. Conservation of biodiversity is directly relevant to local residents, for whom biological resources often represent their primary source of livelihood, medicine, and spiritual values. Nation-states may also express values related to biological resources, often in relation to economic benefits brought about through biological resource use, both consumptive (timber harvesting, hunting) and non-consumptive (tourism). Biodiversity conservation has become an international issue as well, based on a global concern for maintaining the existing species richness on earth, expressed in terms of the common heritage of humans (Johnson, 1992).

These different values can be difficult to reconcile. It is important to be able to clarify different values that underlie positions taken on various sides of a given issue relevant to biodiversity and to understand how values can affect willingness to adopt different patterns of resource use or to reach compromises. Many traditional societies fostered belief systems as well as social norms which encouraged or even enforced limits to exploitation of biological resources. Economic change, population growth, and other factors, however, have brought far-reaching shifts in traditional patterns (BSP, 1993). There is a need to assess the ways in which cultural practices and value systems have fostered conservation in specific settings and to investigate how such cases can be encourage, strengthened, and replicated. Value systems compatible with sustainable development cannot be prescribed, but must emerge through local participation, and with respect for traditional beliefs and practices that have effectively conserved biodiversity for centuries.

Chapter three

3 Materials and methods

3.1 Description of the study sites

3.1.1 Location and topography

Alamata district is located in the southern zone of Tigray bordered by Raya Azebo in the north, Ofla in the west, the Amhara national regional state in the south and Affar national regional state in the east. The geo referenced range of the district is between latitudes of 12^0 $25^{'}$to12^0 $56^{'}$N and longitudes of 39^0 $23^{'}$to39^0 75'E. It is situated 600km north of Addis Ababa and about 180km south Mekelle the regional administrative city of Tigray. It has ten *kebeles.* Namely; *Timuga, Selen Wuha, Limat, Selam Bikalsi, Kulugize Lemlem, Gerjale, Taeo, laelaydayu, Tsetsera and Merewa*.

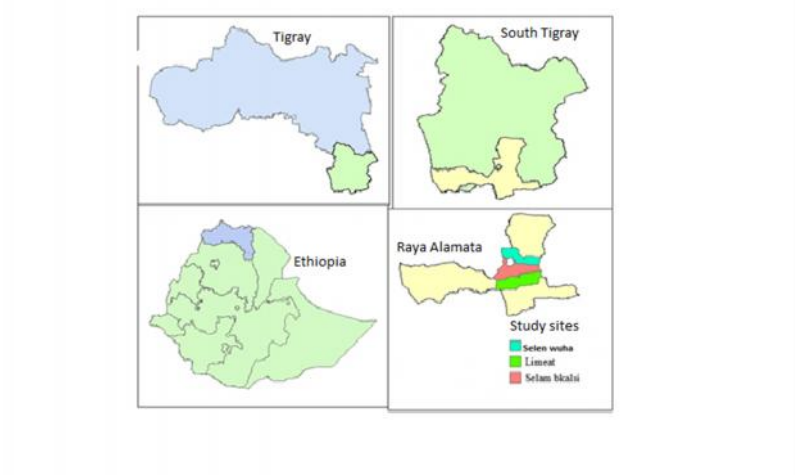

Figure 1**:** Location of the study area in a map

Topographically, Alamata is divided in to western high land and eastern lowland. The western part (*Tsetsera* and *Merewa*) is categorized under the northern high lands of Ethiopia having an altitude range between 2000 and 3000 meters above sea level. It is characterized by steep slopes, gorges and undulating terrain with scattered flat lands used for grazing livestock and farming. It covers 25% of the district. The topography of the area dominated by steep slopes has induced erosion. The eastern low land with its eight *Kebeles* is generally, plain in topography with an altitude ranging from 1450 to 1750 meters above sea level. The plain

landscape of this area makes suitable for agriculture that covers 75% of the district (Office of Plan and Finance of Raya Alamata district, 2015).

3.1.2 Soil and climate

The soil type is Eutric Cambisols and Eutric Fluvisols (STZ, 2007). In which Cambisols are developed in medium and fine texture soils and most of these soils make good agricultural land; extensively used and they are among the most productive soils on earth. Fluvisols is good naturally in fertility and many dry land crops are grown on these types of soils. In addition, local studies shown the soil in the study area is good for agricultural productivity and includes the four main types known as clay, loam, sandy and salty (Girmay Tesfay *et.al*.2014)

The study area is characterized by bimodal rainy seasons which are summer and spring. The summer season lasts for about four months of June to September, 0f which, rainfall is peak in July while the spring lasts for short rainy season between months of March to May. There is climate difference between the eastern lowland and western highland of the district. The eastern lowland of district is hot to warm sub-moist type where mean annual temperature is18^0c to 27^oc. The rainfall showed with small peak in April and maximum peak in August. According meteorological data of the area rainfall is highly variable and evapo-transpiration is high. The western highland is categorized under sub-moist highlands. Its mean annual temperature is ranging from 12^0c to 18^0c.Though the amount of rainfall is relatively low, the variation for the highland area is moderately variable. The total annual rain fall of the woreda is 861.5 mm (Office of Plan and Finance of Raya Alamata district, 2015)

3.1.3 Population

According to 2015 survey, the total population of the study area is about 94,004. Of this, 46,438 is female population and 47,566 is male population. The total number of household heads of this woreda is about 22,156. Of this, 10,992 are male household heads while 11,164 are female household heads. The estimated average population growth rate of this woreda is 2.5% (OPFWRA, 2015). This is about 2.3% of the total population of the Tigray regional state. If the current population growth rate of this woreda maintains, it will take about 28 years to double itself. This means the population of the study area will be 208,442 by the year 2034. This will be resulted in the shortage of arable land and other natural and human made resources.

3.1.4 Land Use and farming system

A mixed farming system with the predomination of crop production is practiced in the district. Cultivable land, pasture and forest occupy about 67.8% and 8.5% and 8.2% of the total land area, respectively. The remaining area (15.5%) is non-usable, water body, settlement and other land use types of the total cultivated land (14.535 ha). Annual crops occupy 97.9% permanent crops grazing land, wood land fallow land and other lands occupy 0.08%, 0.03% and 1.1% of the cultivated land respectively.

Permanent crops fruits and permanent plants like chat, the average size of land holding for the district 0.88 hectare. The major food crops growth in the area are create, occupying 93.6% of the total cultivated area of temporary crops in the 2015/16 cropping season followed by pulses covering 5.9% oil seeds covering 0.22% vegetables occupying 0.21% and root crops and other stimulants covering only 0.07% of the cultivated area of temporary crops. Sorghum, *teff* and maize are the major cereal crops grown in the area. Moisture stress, weeds and invasive species (*Parthynium striga* and *prosopis juliflora*), Unavailability of improved agricultural technologies, crop pests and diseases, post-harvest losses, salinity and water logging problems, poor water harvesting and irrigation agronomy practices, deforestation and soil erosion in the foot hills are the major production constraints in the area (TARI, 2004).The district is known for livestock production. The average livestock holding of the district was 4.42 total livestock unit per-house hold livestock are kept for the support of crop enterprise and transporting, cows for the production of replacement stock and milk for house hold consumption and sheep and goats are kept as assets, which can be exchange in to cash at times of need.

3.1.5 Vegetation

Available natural vegetation coverage is very small and the woreda covered by residual and pocket forest trees found in communal forest, churches forest and area closures. The presence of *Grat Kasu* natural forest also covers a good part of the forest cover. The lowland parts of the district dominated by *Acacia* species and the highland with evergreen forest (TARI, 20017)

3.1.6 Site selection

As one of the objectives of the study was to compare vegetation of the communal forests to that of open areas, purposive sampling method was used. *Kebeles* with communal forests and free grazing land adjacent to each other were selected as study sites. Those communal forests

and free grazing lands having similar vegetation cover in the past were considered during site selection based on information obtained from users. In addition geological parent material, altitude, rainfall, aspects and drainage were also considered to select the sites. Accordingly, three of the ten *Kebeles*, were suitable to the study (Table 2).The three *Kebeles* are located at different distances, but in the same direction that is from Alamata town, K-1 *(Selen-Wuha*) is located 18 km away from the center of Alamata town, K-2 (*Selam Bekalsi*) is located adjacent to Alamata town and K-3 *(Lemat*) is located 8km away from the Alamata town. The selected *Kebeles* are found in the low lands of the district

Table 2: Distribution of study sites by *Kebeles* and villages in Alamata district

Name of *Kebele*	Name of Village	Name of *Gotes*	Name of communal forest
K1(Selen Wuha)	*BedenaLeko*	*Tigre Mender*	*Alage*
K2(SelamBikalsi)	*Hasheya*	*Dima*	*Keren Awulie*
K3(Limat)	*Kutiche*	*Taeo*	*Keren Tao*

3.1.7 Vegetation sampling method

A systematic random sampling method was used to locate the sample plots in order to generate the woody plant species inventory data, that could help to investigate species composition, diversity, abundance, dominance, similarity and population structure (Kent and Coker, 1992). The transect lines were laid in the ground starting at the randomly selected point at the edge of the forest, keeping the north-south direction with the help of compass, and were separated by 50m interval (Tefera Mengistu, 2001) following (Emiru Birhanu, 2002). At this interval of spacing sample plots with 20m x20m, 10mx10m, 5mx5m and 4mx4m size were established for trees, saplings, seedlings and herbs sampling respectively. (Abebe Gebrehawaria, 2007). The sample plots were arranged in concentric manner (Figure 2).

Figure 2: Arrangement of sample plots with nested compartments A, B, C and D

Using this system from each sample size a total of 24 plots were laid out. And the number of sample plots per sites varied according to the total area of the land uses to assess the regeneration status of woody plants, individual woody categorization were made as height <0.5m and dbh<2.5cm seedling, h>0.5m and dbh between 2.5 and5cm sampling and h>0.5m and dbh>5cm tree. The categorization was made based on preliminary survey of the study sites. The measurement taken in each compartment is presented in (Table 3)

Table 3: Types of vegetation measurements taken in each compartments

No	sub-plot	Size	Measurement
1	A	20mx20m	All woody plants with height >0.5m and diameter>5cm were recorded Diameter and height of each tree were measured.
2	B	10mx10m	Samplings which have a height >0.5m and diameter<5cm was recorded and measured based on species.
3	C	5mx5m	Seedlings which have height < 0.5m and diameter <2.5cm the number were recorded based on species.
4	D	4mx4m	The abundance of herbaceous species was estimated visually.

3.1.8 Socio-economic sampling methods

First preliminary survey was carried out that included filed observation formal and informal discussion with professionals, administrative officers and representatives of the local people. This survey was used to identify the users of selected communal forests so; purposive

selection of households of that are users of the three communal forests was done from the three *Kebeles.* Then, stratified random sampling was used to select the households in order to include female house hold heads; this is because male and female house hold heads could have different attitude and perception towards communal forests of woody plant species. Total of 120 households were sampled using the above method from the respective list of farmers in the selected three *Kebeles* using proportional to size sampling. Equal no. of users was selected from each *Kebeles*, thus the same sample size (40 households) was taken from each *Kebele* (Table 4).The informants of female household heads were 15.8% of the total informants. The total sampled households were 22% of the user's population.

Table 4: Distribution of sampled household heads in each study *Kebeles* of Alamata District

Kebeles list	Total users HHHs	%	Sampled HHHs
K1 (SelenWuha)	200	20	40
K2 (SelamBikalsi)	185	22	40
K3 (Limeat)	180	22	40
Total	565	22	120

3.2 Data collection

3.2.1 Vegetation data

From compartment A, name of species (vernacular and scientific), number of trees per species, tree height using clinometers and diameter at 0.5m using caliper has been recorded.

From compartment B, name of species (vernacular and scientific), number of saplings per species and diameters above the ground using caliper was recorded.

From compartment C, name of species (vernacular and scientific), and number of seeding per species has been recorded in addition from compartment D, herbs ground covers was visually estimated.

Species identification was done with the help of local knowledgeable elder persons and the nomenclature was done following the flora of Ethiopia, honeybee flora of Ethiopia (Reinhard and Admasu,1994) and useful tree and shrubs of Ethiopia (Azene,2007).

Socio-economic data: During the field observation and surveying, interview was made with informants and relative data were collected in accordance.

House hold sampling survey

The house hold survey was conducted using semi-structured interview (Appendix I). This was done to know the attitude and perception of the users towards the communal forests. This questionnaire was developed based on literature review, preliminary survey (Pre-test).

Having refined questionnaire, enumerators were then trained on low to use is recruitment of the enumerators was based on their familiarities with the locality and the people. In addition key in formants that organized village meeting and set convenient time for individual interviewees and provide relevant information was selected

Socio-economic setting

Population characteristics (personal) that is Age, gender, educational status, marital status, family size, occupation etc. and economic characteristics that is wealth status and land holding of users was collected.

Group discussion

This group discussion was done in order to understand the local forest management institutions so, focus group of 5-8 farmers who have detail knowledge about the communal forest and the institutions setup were selected for group discussion. The group consists of present and past leaders of the local forest institutions, elders, and guards of the local communal forests, young people and women. The group discussion was made in the holy days so that the people could have enough time to discuss. The type of data collected was:

Institutional arrangements:

Defined boundary and users rules for exploiting the forest, collective choice arrangements sanctions and conflict resolution mechanisms of the informal institutions at local level was collected. Finally, data was collected from office of agriculture and *Kebeles* administrative in order to know their attitude and perception through interview.

3.3 Data Processing and analysis

3.3.1 Species area curve and basal area:-

The species area curves were drowning following (Lemprecht, 1989) with the x-axis representing each additional sample area, and the y-axis representing the number of species encountered. The basal area was calculated and converted to per hectare basis following Aka (2000) using excel.

g = $\sum_{i=1}^{n}$ $\frac{\pi Di^2}{4}$ = where, Di = diameter of each tree in the sample

N = number of trees in the sample

3.3.2 Species composition of the lands

The land use types was described in terms of species composition, species abundance, frequency and importance value index (IVI). Where there were trees with diameter at 0.5m height greater than 5cm in diameter, dominance was also calculated abundance is the number of individuals of a species frequency is the percentage of plots (sub-plots within the plots) where the species occurs dominance is the rank based on the basal area of a species (Lemprecht, 1989). The IVI was a sum of relative abundance, relative frequency and relative dominance (Curtis and Mcintosh, 1951). Each species was listed and the abundance of each species was entered in the list. A paired t-test was done to see if there was any significant difference or abundance of species, and their abundance of the two land uses (Sara, 2003).

Ground cover of herbs: To assess the ground cover of herbaceous species in the communal forest and open area, the proportions cover of all herbs in each plot was categorized in to arbitrary ground cover classes (Heinz, 1972).

3.3.3 Indices of species diversity and evenness of species distribution

The Shannon- wiener indices of diversity and evenness was used to look at the level of species diversity and evenness of species distribution (Kent and Coker, 1992)

$$H = \sum_{i=1}^{S} pi \ln pi$$

Where

H' = the Index of number of species Diversity;

S = the species number

Pi=n/N is the proportion of individuals found in the ith species

n=number of individuals of a given species;

N=total number of individuals found (Shannon and Wiener, 1949).

Pi=proportion of S made up of the i^{th} species.

J= Σ pi lnpi / ln or J= H'/lnS, Where:

H' = Shannon-Wiener Diversity Index

S = the number of species found in all sampled plots

Pi = the proportion of total individuals in the i^{th} species

The paired t-test was used to test it the diversity and evenness values of the different land use systems was significantly different from one another. To do this the paired list of the values PiInPi/Ins in each land use was testing using the paired t-test.

Species richness: species richness was analyzed by adding the number of all species encountered in the plots each land uses (Adetris, 2006).

3.3.4 Coefficient of similarity of the different land use types:

The species of the two different land use types was compared according to Sorensen (1948). The formula used to calculate the similarity indices is as follows:

Ks =2c/a+bx100 where Ks = Sorensen's similarity coefficient

c = number of species common in two sites

a = number of species found in site one

b=number of species found in site two

Descriptive statistical data obtained from the sample households was compared and contrasted. Descriptive statistics such as percentage and frequency of occurrence was employed to assess farmers' attitude and perception on the communal forest. The data was analyzed with SPSS version 13 using software, chi-square test (x^2) sex, age, weather, education, oxen possession and occupation of the respondents was used to as independent variables. The dependent variables were attitude and participation of the local people to wards communal forests. Data obtained from the group discussion was analyzed descriptive

Chapter four

4. Results and discussions

4.1 Results

4.1.1 Species diversity of woody plants

To draw and judge the adequacy of sampled areas to represent the species diversity and related vegetation qualities, The leveling out of the species area curve is used to determine whether adequate samples were taken. The species area curve is a cumulative curve that relates the occurrence of species with the area sampled. Since the curve grows up and flattened at the end, *Alage* had the highest species of sampling diversity. *Keren Awulie* and *Keren Taeo* had much less species diversity of sampling than *Alage*. The free grazing lands had the lowest species diversity of sampling. The third free grazing land did not have sampling. Again *Alage* had the higher species diversity of seedlings. *Keren Awulie* and *Keren Taeo* had less than species of seedlings than *Alage*. However, the free grazing lands had the lowest species diversity of seedlings.

4.1.2 Diversity, composition, abundance and basal area of woody plants of trees (>5cmat0.5m heights)

A total of 40 species of woody trees were recorded in the three communal forests. 73% of the species were recorded in *Alage* communal forest while only 6species were recorded in the free grazing lands a total of 29 woody species of trees were recorded in Alage while four were in the free grazing land 1. Similarly, *Keren Awulie* and *Keren Taeo* had eight and three species of trees respectively. *Keren Taeo* had the lowest species diversity of trees. The free grazing 1 and free grazing 2 had four and two woody species respectively (Table 4).

As the respondents explain many species disappear from the communal forests as they compare with the original forest condition. In *Keren Awulie*, even though, the name *Keren Awulie* and the history of the site indicated that *Olea europaea* sub spp. *Cuspidatae* was dominant species, but now no one of this sub species is found in the standing vegetation which may indicate the possibility of local disappearance in the event of death of the existing few individuals For trees with diameter greater than 5cm, dominance was also calculated.

According to the importance value index (IVI), the three most dominant species found in Alage are *Acacia asak, Acacia bussei* and *Dichrostachys cinerarea* and in communal forest of

Keren Awulie the three most dominant species were *Acacia asak, Acacia etbaica* and *Acacia tortilis* (Appendix I). Similarly, *Acacia asak* is the most dominant species in *KerenTaeo*. It represented 273% of the total dominance. *Acacia asak* is the most dominant species for all communal forests. *Acacia asak* was the most dominant species in the free grazing 1 too. This species is a pioneer species;

Figure 3: Showing the vegetation cover of communal forest and free grazing land in *Keren Awulie*

In *Alage*, an abundance of 338 individuals/ha of woody species of trees were encountered. Similarly, in *Keren Awulie* and *KerenTaeo*, an abundance of 350 individuals/ha and 313 individuals/ha were recorded, respectively.

Except free grazing 1, the rest free grazing possess the lowest abundance in the study areas. Taking all species of woody plants, even though the abundance of the communal forests are small (Table 4), they are significantly greater than the adjacent free grazing lands at ($P<0.01$).

Basal area of all woody plants with diameter of >5cm was 1.57m^2/ha for *Alage*, 3.82m^2/ha for *Keren Awulie* and 2.94m^2/ha for *Keren Taeo*. The basal area of free grazing 1 and 2 were 0.52m^2/ha and 0.09m^2/ha respectively (Table 4).

Table 5**:** Summary statistics of important parameters of trees

Kebeles	Communal forests				Free grazing lands				P-value for abundance
	N/sp	N/ha	B/ha	F/ha	N/sp	N/h	B/h	F/ha	
Kebele 1	29	338	1.57	460	4	192	52	666	**
Kebele 2	8	350	3.82	305	2	25	09	558	**
Kebele 3	3	313	2.94	460	0	-	-	-	**

Number of species encountered per the land uses: "N/spps" abundance per ha "N/'ha" total basal area per ha "B/ha" total frequency per ha "F/ha" however the in detail result is put in (Appendix I).

**Significant different at p value= 0.01

4.1.3 Diversity, abundance and basal area of woody plants of samplings (>2.5cm and <5cm at the basal stem diameter)

From the 37 species of sampling found in *Alage*, *Dichrostachy scinerea* and *Dodonaea angustifolia* are the most dominant species of the samplings. These species grow in a variety of habitats and rapidly colonizes open area of recently cleared forests. The higher number of species of woody plants in sampling stage than tree stage indicated that the forest is under active and *Acacia* restoration. It also shows a potential to develop into good forest. In case of free grazing1, the number of species recorded was three *asak* was the most dominant samplings.

Similarly, in *Keren Awulie* eight species were recorded and the dominant species of the samplings were *Acacia etbaica* followed by *Acacia asak*, and *Acacia seyal. Acacia oerfota* was the most dominant shrub species of sampling in the free grazing 2. Similarly, only 3 species were encountered in the *Keren Taeo. Acacia asak* was the most dominant species of sampling in the communal forest and its adjacent free grazing land of *Lemat* (Appendix I).

In *Alage* the abundance was 3096 individuals/ha while free grazing 1 had only abundance of 434 individuals/ha. Similarly, the abundance of *Keren Awulie* was 314 individuals/ha respectively while it's adjacent free grazing land has an abundance of 100 individuals/ha. A lower proportion of sampling of *Keren Awulie* showed less potential for the restoration of a woody community. In *Lemat*, the abundance of the *Keren Taeo* (which is communal forest-3*)* was 615 individuals/ha (Table 5).

Table 6: Summary statistics of important parameters of sampling

Kebeles	Communal forests			Free grazing lands			Remark
	N/spps	N/ha	F/ha	N/spp	N/ha	F/ha	
Kebele- 1	37	3096	487	3	434	131	
Kebele- 2	8	314	159	2	100	133	
Kebele- 3	4	615	143	0	-	-	

Number of species encountered per the land uses: “N/species”, abundance per ha “N/ha”, total frequency per ha “F/ha” the detail result is put in (Appendix I).

4.1.4 Diversity, abundance and basal area of woody plants of seedlings (<0.5m heights and <2.5diameter at basal stem diameter)

In *Alage,* 30 species of seedlings were recorded while six species of seedlings were recorded in free grazing land 1, Similarly, *Keren Awulie*, seven species of seedlings of woody plants was recorded and six species of seedling were recorded in free grazing 2, In *Lemat*, only 5 species were recorded in *KerenTaeo* and 4 species were in free grazing 3 (table 6).

Dodonaea angustifolia is the most dominant seedlings in *Alage*. In the free grazing 1, *Acacia asak* was the most dominant species of seedlings. *Acacia asak* was the most dominant species of seedlings in *Keren Awulie* and *Keren Taeo, Acacia oerfota* was the most dominant species of seedling in both the free grazing land 2 and 3 (Appendix I).

The abundance of woody plants of the seedlings of *Alage* was 10,654 individuals/ha while free grazing 1 had only 806 individuals/ha. Similarly, *Keren Awulie* had abundance of 2727 individuals/ha while free grazing 2 had 677 individuals/ha. However, all individuals found in free grazing land 2 were *Acacia oerfota* species of shrub. *Keren Taeo* had possess a total of 2885 individuals/ha and free grazing 3 had 133 individuals/ha (Table 6).

Table 7: Summary statistics of important variables of seedlings

Kebeles	Communal forests			Free grazing lands			Remark
	N/spp	N/ha	F/ha	N/spec	N/ha	F/ha	
Kebele-1	30	10,654	341	6	806	298	
Kebele-2	7	2727	168	5	677	233	
Kebele-3	5	2885	271	4	133	133	

Number of species encountered per the land uses: “No of Species”, abundance per ha “N/ha”, total frequency per ha “F/ha” however the in detail result is put in (Appendix I).

4.1.5 Ground cover of herbs

As it is presented in table 7, in *Alage* communal forest, 77% of the plots had good cover of herbaceous plants. In free grazing 1, only 20% of the plots were under intermediate cover of herbaceous and 75% of the plots were under poor ground cover of herbaceous.

Similarly, 74% of the plots were under good cover of herbaceous in *Keren Awulie*; however, none of the plots were under good cover of herbaceous in free grazing 2. In *KerenTaeo*, only 55% of the plots were under good cover of herbaceous while no plot was under good cover in free grazing 3.

Table 8: Number of plots categorized under ground cover classes in the communal forest and open grazing areas

Kebeles	Sites	Ground cover classes			
		1	2	3	4
Kebele-1	Communal forest 1	0%	9%	14%	77%
	Free grazing 1	75%	5%	20%	0%
Kebele-2	Communal forest 2	0%	11%	15%	74%
	Free grazing 2	83%	10%	7%	0%
Kebele-3	Communal forest 3	25%	6%	14%	55%
	Free grazing 3	84%	11%	5%	0%

Ground cover class: 1 = 1-25% (poor cover), 2 = 26-50% (thin cover), 3 = 51-75% (intermediate), 4 = 76-100% (good covers)

4.1.6 Diversity, evenness and similarity of woody species

As it can be seen in the table 8, the species diversity of trees of *Alage* and *Keren Awulie* were greater than their adjacent free grazing lands and they were statistically significant different at ($p<0.01$). The high diversity values of communal forests compared with open areas indicate the importance of the communal forests for the conservation of genetic resources of the woody species. Increases in the value of the indices indicate more species diversity. Grazing land 3 has no tree.

The J evenness value looks at the abundance distribution among the species occurring in a certain site. The higher the value of J, the more evenly distributed is the abundance among the species (Kent and Coker, 1992). All the diversity and evenness values in all the land use types

were found to follow the normal distribution, thus allowing the utilization of the test. The evenness of the species of trees values showed no significant difference among all land uses. Similarly, all the communal forests showed significant difference in species of sampling and seedlings diversity as compared to the grazing lands

Table 9: Shannon-Wiener indices of diversity and evenness of trees in the different land use types.

Life forms	Land uses being compared	H	J	P-values	
				H	J
Trees	*Alage* Vs. Free grazing 1	2.61-0.91	0.77-0.66	**	NS
	Keren Awulie Vs. Free grazing 2	1.16-0.63	0.60-0.38	**	NS
Saplings	*Alage* Vs. Free grazing 1	2.71-0.93	0.75-0.84	**	NS
	Keren Awulie Vs. Free grazing 2	1.65-0.25	0.79-0.35	**	NS
Seedlings	*Alage* Vs. Free grazing 1	2.54-0.90	0.74-0.50	**	NS
	Keren Awulie Vs. Free grazing 2	1.15-1.20	-0.69-0.74	**	NS
	Keren Taeo Vs. Free grazing 3	1.14-0.64	0.71-0.47	**	NS

**= Significant different observed at 0.01

NS= No significant difference observed at 0.01

Similarity

The species of the six different land use types were also compared according to (Sorensen, 1948) and the method considers presence or absence of species. When all species is taken, the species compositions of all communal forests were different from the free grazing lands. *Alage* was more different from their corresponding open grazing land than *Keren Awulie* and *Keren Taeo. Keren Awulie* and *KerenTaeo* had 37.5% and 33.3% species in common with free grazing 2 and free grazing 3 respectively (Table 9).

Table 10: Species similarity indices' of the different land use types, where all species are used for comparison

Land use types compared	Sorensen (1948)
Alage Vs. Free grazing 1	29.5
Keren Awulie Vs. Free grazing 2	37.5
Keren Taeo Vs. Free grazing 3	33.3

4.1.7 Population structure of woody species

The diameter distribution of the communal forests for all woody species shows higher number of individuals in the lower diameter class than the higher diameter class. *Alage* seems to have an inverted J shape. There is relatively higher number of individuals with lower diameter class than higher diameter class in *Keren Awulie*.

Similarly, in *KerenTaeo*, though, there is higher number of individuals with lower diameter classes, the seedlings were dominated by shrub *Leucas abyssinica* next to *Acacia asak*.

Though, there is relatively higher number of stem with lower diameter classes in *Keren Awulie*, this does not mean that it is in good regeneration trend. The drown graphs shape (fig 7) also indicates they are under insufficient number of seedlings to sustain the forest as most of the graphs did not appear to be like that of reverse "J" shape which indicates whether a given forest area is distributed or not (Demel Teketay, 1997). In the case of the free grazing lands, even though there is high number of lower class diameter individuals than higher diameter class (fig 8) the recorded individuals are dominated by a shrub *Acacia oerfota* species.

The most abundant species for the three communal forests (*Acacia aska*) had an inverted J-distribution. The high proportion of seedlings shows a self-maintaining population structure implying the probability of being the main species in the recovery of the woody community (Emiru, 2002). More than 85% of the communal forests population had diameter distribution of less than 5cm. *Keren Awulie* had possessed the highest number of individuals of trees than All land uses (figure 4)

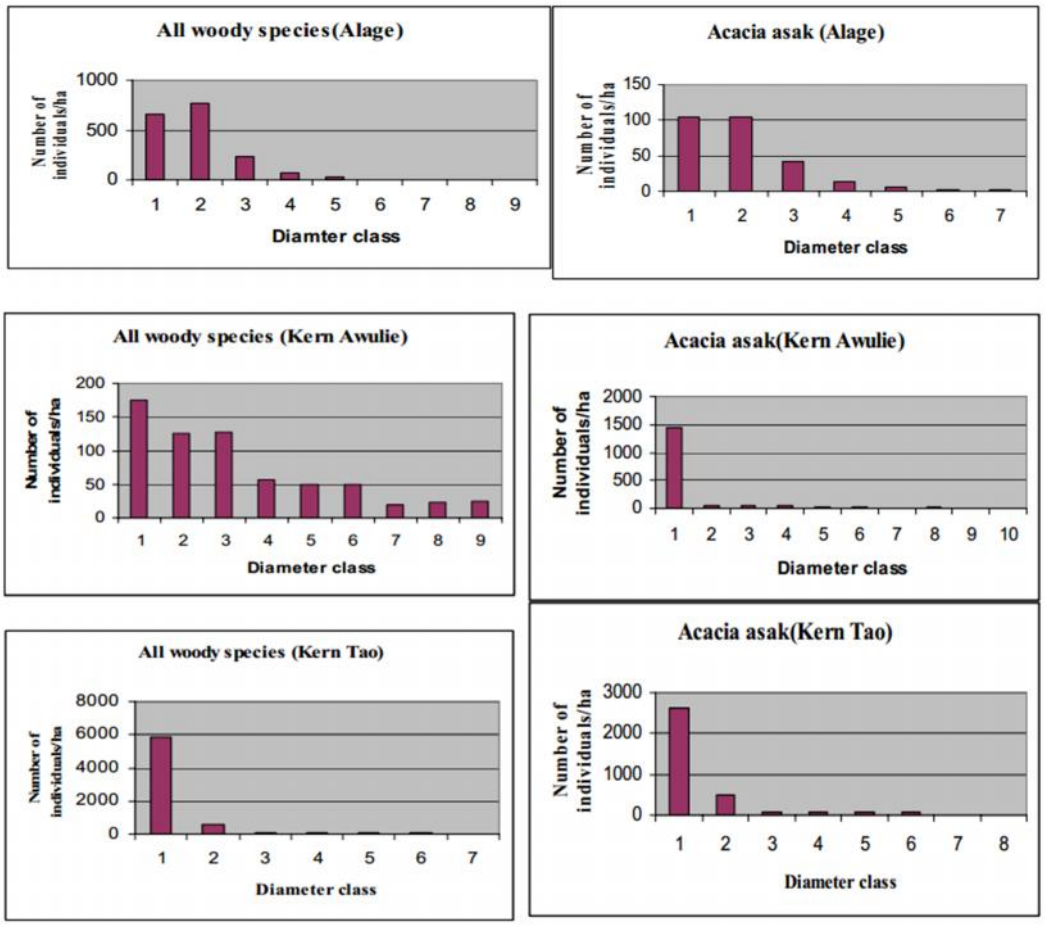

Figure 4: diameter class (cm) distribution of all woody plants encountered in all plots of the communal forests and the dominant woody plant. Diameter class: 1 > 2.5cm, 2 = 2.5-5, 3=5-7.5, 4=7.5-10, 5=10-12.5, 6=12.5-15, 7=15-17.5, 8=>17

The height class frequency distributions of woody species of the communal forests are shown in figure 6. Woody species with height less than 3m contributes more than 85%. Like the diameter distribution it can be seen that the height distribution follow similar trend.

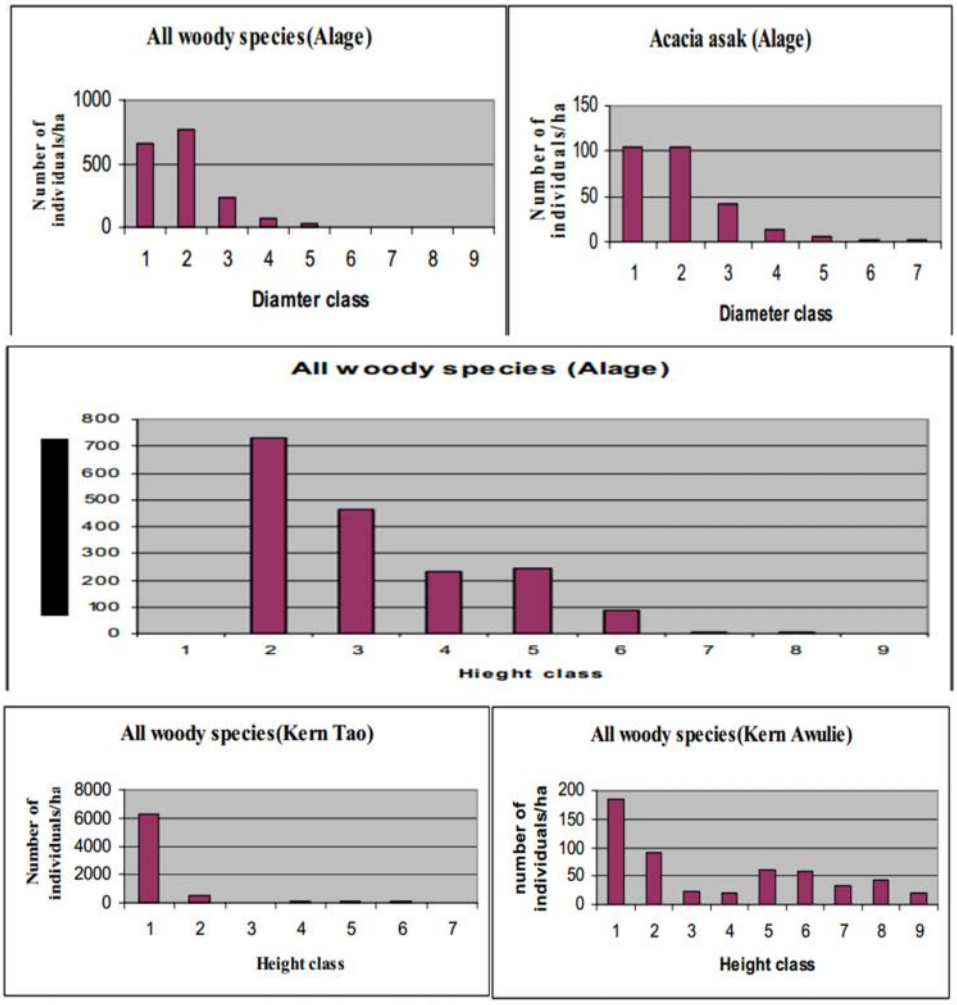

Figure 5: frequency distribution of height classes (m) for woody species of communal forests: Height class 1 <1m, 2=1-2m, 3=2-3m, 4=3-4m, 5=4-5m, 6=6-7m, 7=6-8m, 8>8m

The diameter distribution for the open grazing land also shows an inverted J shape. The percent of seedlings, saplings and trees for free grazing land 1 was 40%, 16% and 44% respectively. For free grazing land 2, the percent of seedlings, saplings and trees was 34%, 60% and 6% respectively. There were no trees for grazing land 3

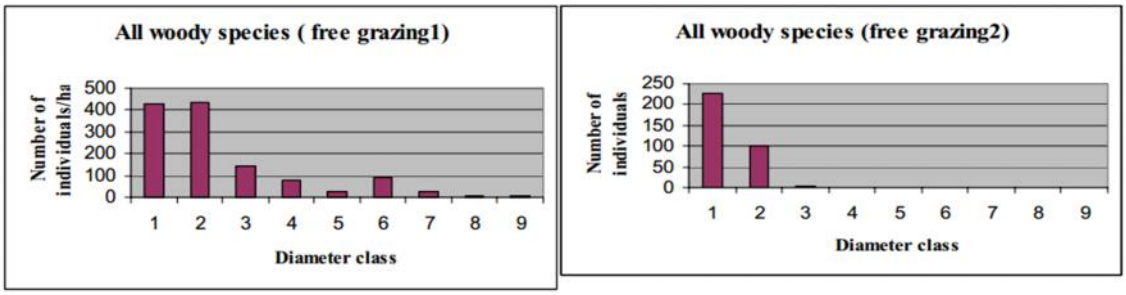

Figure 6: diameter class (cm) distribution of all woody plants encountered in all the plots of free grazing land Diameter class: 1<2.5cm, 2=2.5-5, 3=5-7.5, 4=7.5-10, 5=10-12.5, 6=12.5-15, 7=15-17.5, 8>17.5cm

In free grazing 1 the height class distribution showed that irregular pattern. It seems to have higher number of lower class height than the higher height class. However, the same to diameter distribution it is dominated by some shrub. Similarly, the free grazing 2 showed that higher number of height class which is dominated by a shrub *Acacia oerfota* species.

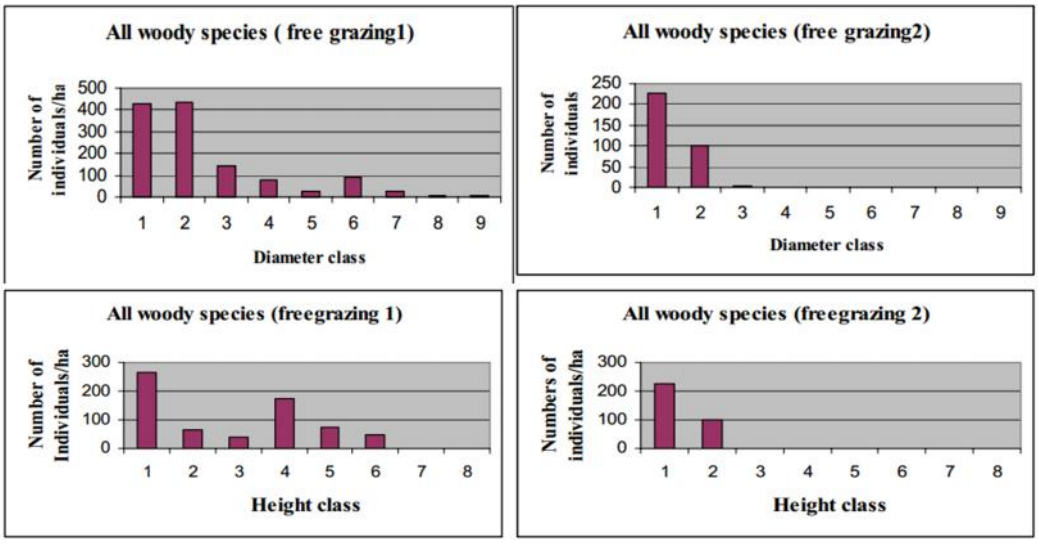

Figure 7: frequency distribution of height classes (m) for woody species of free grazing lands: Height class 1 <1m, 2=1-2m, 3=2-3m, 4=3-4m, 5=4-5m, 6=5-6m, 7=6-8m, 8>8m

4.1.8 Socio-Economic conditions

Regarding most of the population characteristics such as male to female ratio, age distribution, marital status, educational status, family size and wealth status, there is no significant difference among the three *Kebeles*. Thus, it is reasonable to treat all samples as one when necessary. However, farm size and most of the domestic animals showed significant difference among the *Kebeles*. Oxen and goat showed no significant difference.

Table 11: Mean comparison of farm size and livestock number among *Kebeles* in Alamata District

Dependent variable	*Kebeles*			Significant
	SelenWuha	*Selam Bekalsi*	*Lemat*	
Farm size	0.99	0.58	0.72	**
Cattle	0.30	1.30	1.50	**
Oxen	1.50	2.00	1.70	NS
Sheep	0.55	0.50	1.90	*
Goat	0.37	1.60	0.57	NS
Camel	0.22	1.02	0.37	**
Donkey	0.50	0.36	0.57	**

*Significant different p=0.05

**Significant different at p=0.01

More than half of the respondents had family size 5-9. In addition, more than half of the respondents had age of 30-50 years.

Table 12: Distribution of sampled household heads by type, age and family size in Alamata District

HHHs type	No respondents	HHHs age	Number of respondents	Family size	Number of respondents
Male	101(84.2%	<30 years	18(15%)	<3	16(13.3%)
Female	19(15.8%)	30-50 years	67(55.8%)	3-4	24(20%)
		>50 years	35(29.17%)	5-9	76(63.3%)
				>9	4(3%)

As it is shown in table 10, majority of the respondents were married and illiterate. Except one person all the informants were dealing with farming only. They did not have additional sources of income.

Table 13: Distribution of sampled households by marital status, education status and occupation in Alamata District

Kebeles	Marital Status						Education				Occupation			
	Single		Married		Divorced		Literate		Illiterate		Farm only		Off farm	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
SelenWuha	5	12.5	30	75	5	12.5	9	22.5	31	77.5	40	100	-	-
SelamBekalsi	1	2.5	32	80	7	17.5	10	25	30	75	40	100	-	-
Lemat	2	5	33	82.5	5	12.5	16	40	24	60	39	97.5	1	2.5
Total	8	20	95	79.2	17	14.2	35	29.2	85	70.8	119	99.2	1	.08

The settlement pattern of the people in the study area is cluster and the homes were located around the bottom of the hills of the communal forests and area closures (figure 11). Regarding the ethnicity of the information, 82.5% were Tigraway and the rest were Amhara. Even though, there are two ethnic groups especially in *Selen Wuha*, almost all were original inhabitants of the place; the difference comes from the border effect of the Tigray and Amhara National regions.

These relate to the homogeneity of the local communities and they contribute to the users to organize easily and have successful indigenous resource management (Ostrom, 1990).

Figure 8: The settlement pattern of the users in *Keren Awulie* and *KerenTaeo* are in a cluster

4.1.8.1 Economic status and land holding

The main economic means of the people in the study area was crop production and animal rearing with the higher reliance on the former. The classification of wealth was done based on local classification methods. Land holding and oxen possession were used as indicators of wealth. A farmer who does not possess land and an ox was considered as very poor, a farmer who owns < 1/2 ha and one ox was consider as poor, a farmer who owns 1/2-1ha and two oxen was considered as rich and a farmer who owns > 1 ha and owns more than two oxen was considered to be very rich.

Accordingly, 2.5% of the respondents were very rich, 57.5% of the respondents fell in the rich category, 35.8% of the respondents were considered as poor and 4.5% of the respondent were very poor (fig. 12). 83.3% of the female respondents were poor. Similarly, 10.8% of the information were landless, 69.2% possess <1ha, 17.5% possess 1-2ha and 2.5% possess > 2ha. Most of the landless were they young people (Figure. 13)

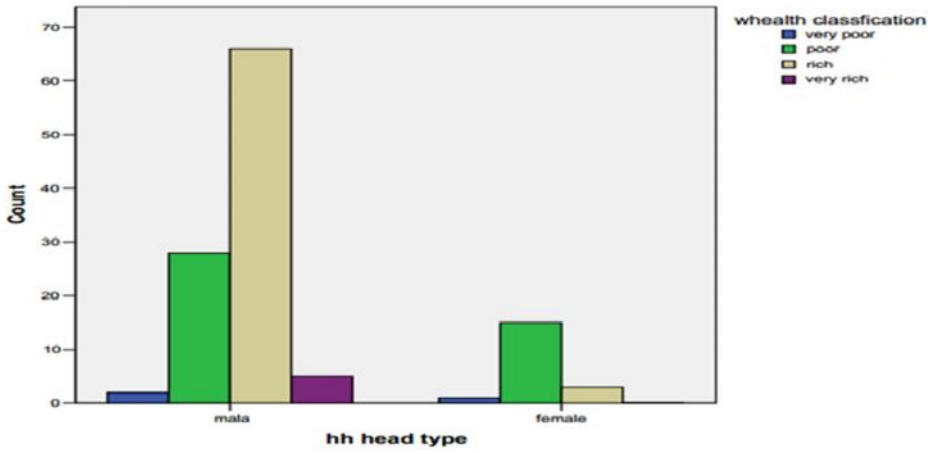

Figure 9: distribution of sampled household by wealth status and by gender in Alamata District

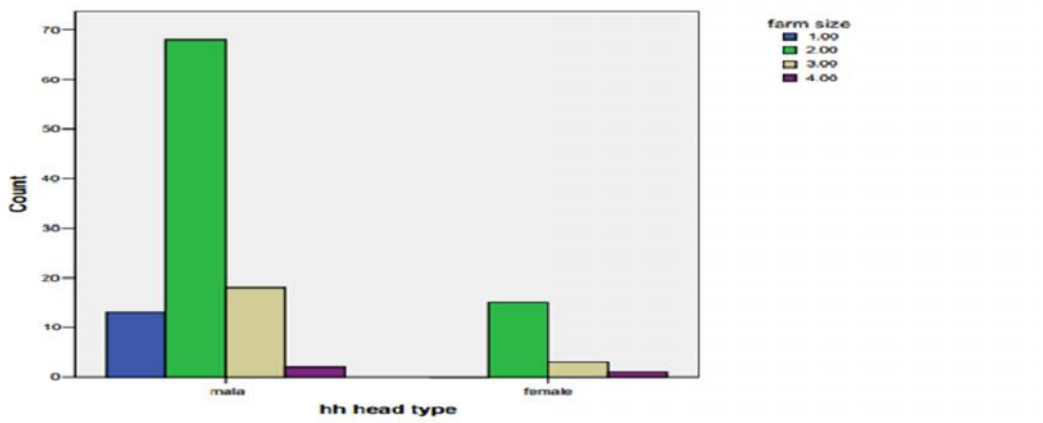

Figure 10: distribution of sampled households by land holdings and by gender in Alamata District: 1=> no farm land 2=<1 ha, 3=1-2 ha, 4>2ha

4.1.8.2 Institutional arrangement

Boundaries and size of the user group

The group of users is restricted to *Gotes* which are smaller than village. In case of *Alage*, the users live in four *Gotes*. Each *Gotes* has its own leaders called *"Aba Haga"* and five assistances who are responsible for the forest management. The assistance is responsible for managing financial related activities. In addition, the leaders and the assistances are also responsible for managing the social activities of the *Gotes*. Each *Gotes* has around 200 household users. The list of the users is known and is put with the leaders. However, the forest is not divided up to the four *Gotes*. They manage the forest as a whole. Similarly in *Keren Awulie*, the users are limited to one *Gotes* called *Dimagiworgis*. The users divided themselves in to three *Keyes*; they are *Gudagudi, Maehelot* and *Kocha*. The users of the three *Keyes* are known. The users live close to the one direction of the bottom of the forest (Figure 11).

The forest is located on the undulating hills of the village rounding the settlement of the users and covers a long distance in length. The forest is divided into three parts so that the people who live near the forest will be responsible for protecting and use the nearby part of the forest. So, each *Keyes* is responsible for protecting its part.

Similarly, in *KerenTaeo*, the users are found to be in one *Gotes* called *Taeo*. Furthermore, the *Gotes* are divided in to two *Keyes*, the two *Keyes* have their own two leaders for the forest management. The list of the users is known and it is put with the selected leaders.

User rules and access to forests

In *Keren Taeo* and *Alage*, the user rules forbid the users cutting trees for any purpose. The only access the users were allowed collection of dry fuel wood and grazing of oxen. The users of *Alage* used to also get benefit from some naturally grown fruits like cactus. The reason for forbidding using non-dry woods in *Alage* and *Keren Taeo* is because the community believed that the forests did not have sufficient amount of satisfy the need of the community. They left the forests for natural regeneration. Similarly, In *Keren Awulie*, the users are allowed to get access from non-dry woods in addition to dry wood and grazing. However, the users should ask first to the leaders and they should also explain for what purpose they need the wood.

They are restricted to ask for wedding, mourning and farm implementation only. Asking wood for house construction is forbidden. The community with the leaders will decide the amount of wood they take and the leaders will select the tree or trees to be cut. The amount is decided based on the wideness of the ceremony. The leader with the community will determine the wideness.

Monitoring and sanctions

In *Keren Taeo*, the monitoring procedure is done by the selected two leaders and the users. There is no guard hired. The community guards the forest turn by turn. The leader will tell the users whose turn it is. As the respondents explain there is no need of hired guards because the forest is small and it is near to the residence of the community so it is easy to protect the forest from illegal cutters.

In *Alage* and *Keren Awulie*, the monitoring procedure is done by the selected leaders, guards and the whole users. The guards are hired when the forest is closed from grazing.

The main responsibility of the guard is to keep the forest for grazing of any animal. However, the guards are forced to guard the forest from illegal cutters, too. The guards are paid in cash by the community. Each user is needed to contribute one birr per ox, Most of the time the guards in both forests are paid 120 birr per month. When there is no guard, the community keeps the forest turn by turn.

The leaders monitor whether the forest is kept in accordance or not. In *Keren Awulie*, if a guard fails to fulfill his accountability, he will be charged10-15 birr. The leader in *Alage* stayed in power for a minimum of a year and maximum of five years. In the rest two forests,

the leaders stayed in power as far as they are strong enough. There is a meeting every Sunday in a month. If there is a need for discussion, the leader can call for a meeting any time.

Sanctions are different from forest to forest. Illegal cutters charged 10 birr in their first experience and 50 birr for second time in *KerenTaeo*. If the person cut trees repeatedly, he will be sent to local courts. The sanctions are not permanent. They can be changed any time according the situation. Similarly, in *Alage* and *Keren Awulie*, the illegal cutters are punished 50 birr and 100 birr respectively. Lastly, if they cut trees repeatedly, they will be sent to the local courts. The penalty is sever for these who repeatedly offense.

Figure 11: Group discussion with the local farmers in *SelenWuha*

Participation

As the informants explained most of the users participate in selection of the leaders, formulating the bylaws and in any meeting regarding the forest. They also participate in contributing cash or labor for protecting the forests. The contribution is related to the rules and regulation of the local community. In *Keren Taeo*, the forest is protected by the local people turn by turn. So they did not contribute cash for guards. All the respondents' response that they contribute labors for the protection of the communal forest. In case of *Alage*, they sometimes hired guards or they guard themselves. So, 30% of the respondents contribute in cash only, 30% labor only and 40% contribute in both cash and labor. In *Keren Awulie*, 90% of the informant's response that they contribute both cash and labor. This shows that the communities are actively participating in monitoring producers. They also have good participation in the forest meetings and in contribution of labor and money for the management of the communal forests.

Concerning the three forests together, 84.2% of the respondents explained that they participated in the forest management meeting they had. Regarding the participation in a meeting they have, the Pearson chi-square value (0.99) revealed that participation and gender shows significant difference at P<0.05 (table14). This is because women did not participate in forest meetings. They believe that woman should not go to meetings, so most of the female household heads did not participate in the meetings. But, they can send their sons if they are adult enough. However, the week participation of women in the meetings is critical since most women rely upon forests for their lively hoods.

Table 14: Relation between local participation and community structure

No	Independent factors	Significant
1	Age	NS=0.99
2	Gender	*=0.001
3	Economic status	NS=1.21
4	Education status	NS=0.64
5	Oxen possession	NS=1.23
6	Occupation	NS=2.00

NS = non-significant

* = significant, at p<0.05

Conflict resolution and recognition of legitimacy

The major conflict raised in the study areas were with non-users from other villages. In *Keren Taeo,* the major conflict raised was with the neighboring *Gotes* in 1992. The cause of the conflict was the *Taeo Gote* residents needed to use the forest in restricted use but the neighboring *Gotes* needed to use the forest as free access. The local administration permitted the neighboring *Gotes* to use the large part of the forest as free access. As a result the *Taeo Gote* remains with the present communal forest.

Even though, the *Taeo* communities were not happy in the *Kebele* administration's decision, they accepted as it is. Similarly, in *Alage*, the nearby villages needed to use the forest as free access. However, the *Kebele* administration did not permit them because the people of other villages had their own communal forest in their village. The only things they want were to get additional benefit.

As the respondents explain, conflict among the users is rare. If there is, it is easily to solve by discussion. This can be due to them every meeting of the users in every Sunday in month. The small disagreement among the users implies successful common-property regimes. But the

conflict with non-users is about the benefit sharing and property right and usually solved with the help of the administration of *Kebele* agriculture office. The respondents also explain that the government and the *Kebele* administration are always besides them. They gave them legitimacy to manage the communal forests.

Grazing arraignments in the communal forests

The respondents explained that since imperial Haileslasie, they used to practice restricted grazing locally called "*Siera*". It was also a long tradition of developing and enforcing use regulation of grazing areas in Tigray (Gebremedhin *et al.,* 2004). The free grazing time for *Alage* and *Keren Awulie* is half June – September and February – May respectively.

In both *Alage* and *Keren Awulie* forests, the users use cash penalties for violations. In *Alage*, the fine for Oxen or cattle illegal grazing was 10 birr while if cowboy is found with them, it can be 100 birr and if it is at night 50 birr per a person. If the fault is repeated it can be 100 birr. In *Keren Awulie*, the punishment is 3-5 birr for any domestic animals. In case of *Keren Taeo*, they did not have restricted regulation. As the respondents explain the communal forest is very steep. The reason for allowing only oxen to graze is that because oxen supply draught power in the study areas.

Technical aspect

As the respondents explained in the group discussion, they do not have any technical practice they use in order to maintain, protect and regenerate the forest. The only thing they do is to leave the communal forests for natural regeneration. However, from the vegetation survey, *Keren Awulie* and *Keren Taeo* need some soil and water conservation structures as the sites are highly affected by soil erosion since they are located in the hill sides.

They also needed to have planting enrichment. Some gully treatments were done to protect from further expansion of the gully by the office of agriculture in *Keren Awulie* (figure 15)

Figure 12: Gully treatment done by BOARD in *Keren Awulie*

Perception of the community towards the communal forests

All the respondents explained that conservation of plants is important. However, 11.7% of the respondents responded that conservation of wild animals is not good because of the increase of the wild animals like Hyena, wolf and leopard become a problem.

The informants classified the forest condition in three periods. During the Hialeslasie regime and before when the original forests exists, there were dense forests and wild animals were also rich. Then deforestation of the forests happened in different conditional as it is mentioned in the tenure history of forests in both *Keren Awulie* and *Alage*, the deforestation was happened in (Table 14). This time is related to the time the local forest management institutions exist. Dergue regime, In case of *Keren Taeo*, the high deforestation was happened at the beginning of the EPRDF. As most of respondents respond, the vegetation cover of the communal forests was increasing. However, it is not the same as the original forest. The wild animals in kind of quantities are increasing

Table 15: Farmers' perception of forest covers changes and number of wild animals in the communal forests in Alamata District

Forest Cover	*Kebeles*			Total
	Lemat	***SelenWuha***	***Selam Bekalsi***	
Still intact	1(2.5%)	2(5%)	9(22.5%)	12(10%)
Better than before deforestation exist	22(55%)	26(65%)	22(55%)	70(58%)
Slightly disturbed	15(37.5%)	9(22.5%)	4(10%)	28(23.3%)
Heavy disturbed	2(5%)	3(7.5%)	5(12.5%)	10(8.3%)
Wild Animals				
Increase	26(65%)	33(82.5%)	37(92.5%)	96(80%)
Decrease	14(35%)	7(17.5%)	3(7.5%)	24(20%)

Forest dependency

Majority of the respondents mentioned that they do not sell any product of the forests. Similarly, even though 53% of the respondents said they conflict fuel wood, all explain that they collect if from elsewhere not from forests. More than 90% said that they have flue wood shortage. Almost all respondents use dry woods, cow dung and crop residue as sources of energy. There is nothing done to help the poor and woman households heads. Regarding grazing lands, 56.7% of respondents said that they have shortage of grazing land.

From the household survey, the benefit of the users depends on the forest condition and them bylaw they had. More than of the respondents of the users of *Keren Taeo* benefit only grazing their oxen and collecting dry woods. In the case of *Keren Awulie*, the users use non-dry woods. In addition, 67.5% of the respondents of users of *Keren Awulie* benefit from non-dry wood in addition to dry wood and grazing

Future ownership and tenure security

In this study, only common property tenure is concerned. Ninety five percent of the respondents prefer the communal forest to continue as it was now that is to be under the control of the individuals, only 5% prefer the communal forests to be divided up to users.

None of the respondents prefer the communal forest be manage by the government regarding the tenure security they feel, 70% of the respondents have a fear that the communal forest might to take by the government (Table 15). This feeling of insecurity could affect their management decisions for the future.

Table 16: Perception of the respondents towards future ownership and tenure security of the communal forests in Alamata district

Future ownership	*Kebeles*						Remark
	Lemat		*SelenWuha*		*SelamBekalsi*		
	No	%	No	%	No	%	
Continue as it is now	38	95	35	87.5	39	97.5	
Divide and share for users	2	5	2	5	1	2.5	
Be under ministry of Agriculture	-	-	3	7.5	-	-	
Tenure security							
Do you feel tenure secure							
Yes	18	45	9	22.5	9	22.5	
No	22	55	31	77.5	31	77.5	

Attitude towards the communal forest management

All of the informants are interested that the communal forest managed by the local forest institutions. In addition, all agree with the rules and penalty they have. As the respondents said the rules and penalties are formulated by themselves. There is no reason that they disagree. All the respondents need the communal forests to be expanded if there is place. Regarding attitude they have towards the communal forest management, there was no significant difference at ($P<0.05$) among age, wealth, education, oxen possession, occupation (Table17).

Table 17: Relation between altitude towards communal forest and community structure

No	Independent factors	Significant
1	Age	NS
2	Gender	NS
3	Economic status	NS
4	Education status	NS
5	Oxen possession	NS
6	Occupation	NS

NS = non-significant at $P<0.05$

4.1.8.3 Perception of Kebele administration and Office of agriculture towards communal forests:

As the *Kebele* administration and Woreda office of agriculture responded, the communal forests were becoming better when compared to the time when the forests were deforested. They responded that the local institutions protected the factors well. They explain that the

Kebele administration and office of agriculture gave the power to protect and use the forests to the community. Because they believed that the communities are managing the forest sustainably. They also explain that it is better for the communal forests to continue under the community management

4.2 Discussion

In *Alage* communal forest the species area curve line increase up to the end with relatively less flattening trend. This could be as a result of high diversity of the area, which is also true from the result of Shannon-wiener diversity index. This the communal forest with the highest diversity index value. The high diversity of *Alage* compare to the other communal forests could be due to nature of the original vegetation and inaccessibility of the area. As the respondents explain it was very rich in species since they have known the forest. It is also rich in wild animal too. *Keren Awulie* and *Keren Taeo* had less species diversity than *Alage*. There were no trees in free grazing land3. Free grazing 1 seems to have higher species diversity than *KerenTaeo*. This is because the local community stopped cutting trees from their surrounding since recent times.

Generally, the vegetation composition of woody species was much denser in the communal forests than the free grazing lands. This indicated that the local institution have played a role in conserving biodiversity of woody species. However, the recorded number of species in *Keren Awulie* and *Keren Taeo* is much less than the species richness reported from dry forest (Daniel *et al*., 2006). This indicated that high deforestation was occurred before the local communities start to protect the communal forests. The species composition, abundance, frequency and importance value index (IVI) were also calculated for all land use types and it is shown in (Appendix I).

In addition, since the communal forest are not completely closed from browsing animals, some species like *Olea europaea* could face high problem because it is highly palatable. However, if high level of protection in the communal forests continues, there may be good regeneration of these woody species since seedling survival of these species can be enhanced by pre-existing early-succession shrubs that serve as nurse-lands, probably through limiting drought stress (Aerts *et al*., 2008). Excluding livestock is an eventual requirement because the shrubs do not protect seedlings efficiently enough against browsing. Therefore, the communities should be

closed the degraded forest land completely from any browsing animals in order to rehabilitate well. Woodland recovery has been associated with decreasing intensities of browser pressure (Walpole *et al.,* 2004).

All the species found in all land uses were indigenous species. This is because no plantation was done in the communal forests. Being all species indigenous makes those communal forests free from the risks of exotic species in their rapid growth rate resulting in high competition for the native trees (Webster *et al*., 2005).

The basal areas of the communal forests are too small. This is because the communities started to protect the communal forests after high destruction of the forests happened. This could be 15-18 years and it is short time to have higher diameter classes. This time was related to the time the communal forest institutions exist. However, the indigenous forest institutions were effective since the basal areas of the communal forests are significantly higher than the adjacent free grazing lands which had the same vegetation cover in the past. The difference comes from different land use management. In addition, the greater difference in basal area between the communal forest and open area could be due to the high number of multi stemmed trees in the communal forest, leading to higher diameters.

The better ground cover of the communal forests than the free grazing lands is due to the restricted grazing system they use. Similar study in Tigray also proved that the use regulations were believed to contribute to a significant regeneration of grazing lands, supporting the role of communal resource management in redressing resource degradation (Gebremedhin *et al*., 2004)

Institutional arrangement of communal forests defining the extent of forest boundaries or the number of users in a group clearly in the study sites, allowed less opportunities individuals to encroach up on forested land. Giving the right to use forest products to the nearby *Gotes* also makes management easier, This concords with the suggestion that groups emerge to manage common property when the user population lives close to the resource and it is relatively small (OStrom, 1993). As it is explained by the group discussion, the reason of dividing the users in to smaller group is that for the ease of the management. Many studies of the indigenous common property systems that have survived through considerable periods of change also identify small size, internal homogeneity have great contribution to the effectiveness of the communal forest management (Arnold, 1998). Study done in Tigray in the collective

management of wood lots also proved that the effectiveness of the management is greater in lower level than higher level (Gebremedhin *et al.*, 2003). However, there are also studies which prove effective forest management institution with large size of users in case of the Van Panchayats in India (Agrawal, 1996).

In case of user rules and access to forests, most of the time 2-3 trees are allowed for wedding and mourning in *Keren Awulie*. One tree is most of the time allowed for farm implementation. This indicates that the local communities have clear and environmental protection rules. In addition giving priority for the forests rehabilitation in the case of the *Keren Taeo* than and *Alage* indicate that the local communities are well aware of land degradation. The clear enforceable rules make also life easier for resource users and for monitors representing the users group, and reduce misunderstandings and conflict.

In monitoring and sanctions even though, McKean, (1992b) and Ostrom, (1990) argue that the communities with healthy common forests were those that recycled the finance and penalties they collected into providing for their guards. In the study sites, the money is used for buying barrels which is used for making "*Tella*". The guards are paid from the collected many from each user one birr per ox. But the collected money cannot cover the payment of more than one guard. However, one guard is not enough for the large forests of *Alage* and *Keren Awulie*. So, it is better the collected money to be for the conservation purpose rather than for social activities

Based on a good participation of forest based meetings, this finding follows a study by (Agrawal and Yadama (1997) who, in their sample of 279 communities, found that the most important form of user participation was the level of investment by the user group in monitoring and protecting activities. The good participation of the users can be seen primarily as a means to achieve specific goals such as building a better management structure and getting natural resources into a good condition.

It seems unlikely that the system is likely to be any more effective (McLain, 1993a). Therefore, efforts by the state of the non-governmental bodies to promote empowerment for women would lead to full participation of the group in forest management discussions

Chapter five
5 Conclusions and Recommendations

5.1 Conclusions

Bases on the species area curves, it is clear that adequate samples had been taken for the study. Assuming that the vegetation of both communal forest and free grazing land was similar some years ago, the vegetation in all the communal forests have a higher wood vegetation composition, densities and basal area. This is due to the management difference of the communal forests and free grazing lands. The communal forests are protected from free access or due factor management. This is done by the local forest management institutions exist. Accordingly, the local forest institution is effective in protecting the forests from being degraded more and becoming open access as their adjacent open areas.

However, the number of species recorded in the communal forests except *Alage* in both *Keren Awulie* and *KerenTaeo* is lower than other dry forest area. This is due to the high deforestation happen before the forest management institutions exist. These communal lands had also less number of lower diameter classes stems. The poor regeneration capacity of these forests indicates the need to apply enrichment planting with indigenous tree species so that the heritage of threatened species will be maintained.

Beside to this, the topographic location of all the study communal forests is on hilly mountainous spot, which is highly vulnerable for serious erosion, it is necessary to implement and strength of appropriate maintenance soil and water conservation structures like gully treatment. The very rich species of woody plant and wild life diversity of *Alage* forest indicate that it has a potential to recover to a very good dense forest and home of wild animals.

From the group discussion, the forest management institutions have established after the high deforestation happened especially in the 1985 when there were high drought in the country. However, they were institutions for grazing arraignment inside the forests in the imperial Haileslasie. The local communities were initiated to protected the communal forest by themselves by realizing that they were the first suffers of the deforestation. This indicated that the local communities were aware of land degradation.

In addition, the institutions are considered indigenous forest management institutions because it is unique for the communities and it is based on the indigenous knowledge of the local communities.

Being the users of the communal forests smaller and homogenous contribute the users to have successful indigenous forest management. It will also useful to have leader who are responsible for the forest management. The monitoring producers are done by the selected leader, guards and the users. This implies that the communities are actively participating in protection. The restricted use rules of the communal forests in order to give chance the forest to rehabilitate indicates that the communities are trying to manage sustainably. The local institutions have also sanctions and conflict mechanisms which are very important in having successful communal management. However, the fines should use for forest conservation rather for buying barrels. Thus the forest management institutions should be free from social activities.

According to the research questions set at the beginning of the study, the following points were proven.

1) The vegetation in the communal forest as compared to that of the grazing land has shown an increased and change in species composition with increased of woody species and grass cover. However, the number of species recorded in the communal forests especially in both *Keren Awulie* and *Keren Taeo* was lower than dry forest area.
2) Almost all the respondents prefer the communal forests to be managed by the local people as it is now. In addition all the respondents are glad the communal forests are managed by the local institutions. These implied that the local communities have positive attitude and perception towards the communal forests. A good attitude towards the communal forests helps in the protection of degraded communal forests for better rejuvenation of woody species.

5.2 Recommendations

Based on the results of the present study, the following recommendations are made:

1) There is higher species composition in the communal forests than free grazing lands. The density, abundance and diversity also outpace the free grazing. As it has saved the forests from being degraded more. Hence, the local institutions that managed the communal forests should strengthen and supported. In addition, government policy on participatory resource management will be more successful if it is facilitative of institutional innovation and adaptation at the village level.

2) All the studies of communal forests are in high threat of browsing animals though they use restriction grazing that is only oxen are grazed in the allowed time. This is because important species like *Olea species* and others are disappear from the standing vegetation. Therefore, these lands should be closed completely from any human and animal interference in order to rehabilitate well. They should use cut and carry system in order to use the grasses.
3) The local communities should be trained and oriented about scientific tree propagation (seed collection, storage and nursery techniques), civic cultural and forest management techniques which may enhance their level of knowledge on top of traditional conservation knowledge since they have limited knowledge in the civic cultural and propagation.
4) It is advisable to identify *Alage* forest as an In-situ conservation site as it is rich in species of woody plants and wild animals. In addition it can be taken as priority forest area since it covers wide area and possess different land escape topographies.
5) In order communal forests are successful & sustainable, the institution should be free from social activities, and the fines should be used for forest conversation rather than for buying barrels.
6) Land tenure insecurity discourages local participation in forest management and forest protection activities. So, the communities should be guarantee to the communal forests in order to feel tenure security.
7) Women household heads should participate in the meetings of the forest management in order to have active participation of women. Therefore, the government should employer women to have active participation in any forest management
8) In order the communal forests be sustainable, the government should always legitimize and assist local groups to formulate and enforce rules of group access too, and non-member exclusion from, common forest areas.

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Appendices

Appendix I List of woody species and important parameters of the three sites

1.1.1 Dominance, abundance, frequency and importance value of the trees in the three lands uses in *Selen Wuha.*

No	Species	Life form	*Alage*				Free grazing 1			
			Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	IVI	Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	IVI
1	*Dichrostachyscinerea*	Tree	47	55	0.117	35				
2	*Carissa edulis*	Tree/shrub	8	14	0.017	7				
3	*Accia seyal*	Tree					17	33	0.065	25
4	*Acacia bussei*	Tree	14	27	0.084	16	58	33	0.529	21
5	*Acacia torilis*	Tree	5	9	0.018	5				
6	*Acacia asak*	Tree	64	41	0.302	48	200	100	1.889	139
7	*Acacia etbaica*	Tree	31	32	0.157	27				
8	*Erythrina abyssinica*	Tree	20	41	0.206	29				
9	*Acokantheraschimpery*	Shrub	1	5	0.008	2				
10	*Vepris nobilis*	Tree	5	18	0.013	7				
11	*Chlorophytumretraphyllm*	Tree	1	5	0.002	2				
12	*Carissa spinarum*	Shrub	1	5	0.025	3				
13	*Eucleaschimperi*	Tree	5	14	0.013	6				

14	*Terminaliabrowni*	Tree	13	18	0.092	14				
15	*Rhusm atalensis*	Tree/shrub	8	18	0.028	9				
16	*FicusovaaVahl*	Tree	1	5	0.007	2				
17	*Oxyrisquardrepatite* Deon		5	9	0.015	5				
18	*Maytenussenegalensis*	Tree/shrub	1	5	0.003	2				
19	*Dodonaeaanguslifalia*	Tree	1	5	0.002	2				
20	*Zizipisspaniyacrisiti*	Tree/s	1	5	0.003	2				
21	*Sclracaryabirrea*	Tree	8	9	0.022	6				
22	*Strychnoshenningsii*	Tree	3	5	0.012	3				
23	*Gomphocarpusfruticosus* (L) Aitf.	Tree	6	14	0.011	6	17	33	0.037	75
24	*Grewia bicolor*	Tree/s	9	14	0.035	8				
25	*Acacia meltis*	Tree	68	23	0.334	47				
26	*RhusglutinosaA.rich*	Tree	1	5	0.004	2				
27	*Oleaeuropea sub sp.cuspidate*	Tree	9	5	0.031	6				
28	*BrideliaMicrantha*	Tree	1	5	0.006	2				
29	*XimeniaAmericania*	Tree/s	3	5	0.011	3				
	Total		341	405	1.57	300	292	200	2.52	300

1.1.2 Dominance abundance, frequency and importance value index of the trees in the three lands used in *Selam Bekalsi*

No	Species	Life form	*Keren Awulie*				Free grazing 2			
			Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	IVI	Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	IVI
1	*Carissa adulis*	Tree/s	1	5	0	2				
2	*Acacia tortilis*	Tree	35	67	0.81	56	17	33	0.295	136.5
3	*Balanitesaegyptica*	Tree	3	10	0.1	7	8	33	1.30	163.5
4	*Acacia bussei*	Tree	6	5	0.03	4				
5	*Acacia etbaaica*	Tree	83	67	1.06	76				
6	*Acacia asak*	Tree	206	88	1.72	136				
7	*Acacia sieberiana*	Tree	15	21	0.1	14				
8	*Acacia seyal*	Tree	1	6	0	2				
9	*Acacia nilotica*	Tree								
	Total		350	269	3.82	300	25	67	1.6	300

1.1.3Dominance abundance, frequency and importance value index of the trees in the three lands used in *Lemat*

No	Species	Life form	*KerenTaeo*			
			Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	IVI
1	*Balanitesa egyptica*	Tree	1	14	0.033	13
2	*Acacia tortilis*	Tree	1	14	0.071	14
3	*Acacia asak*	Tree	311	10	2.835	273
4	*Acacia etbaica*	Tree				
	Total		313	129	2.940	300

1.2.1 Abundance, frequency and modified importance value index of saplings of the woody stems in the three land uses in *Selen Wuha*

No	Species	Life form	*Alage*			Free grazing 1		
			Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)
1	*Dichrostachyscinerea*	Tree	559	64	31	100	33	48
2	*Dichrostachyscinerea*(L)Wight &Arn		18	9	2			
3	*Carissa edulis*	Tree	23	9	3			
4	*Segeretiathea*(Ospeck)M c.Jhonston		68	5	3			
5	*Euclea racemoca*		5	5	1			
6	*Erhrina abyssinica*	Tree	5	5	1			
7	*VerprisNobilis* (TecleaNobilis)	Tree/s	27	9	3			
8	*Chlorophytum tuberosum*	Tree	77	14	5			
9	*Euclea schimper*	Tree/s	118	27	9			
10	*Acacia etbaica* Schein f.(A.Dc)Beath	Tree	5	5	1			
11	*Terminalia brownie*	Tree	9	9	2			
12	*Rhus natalensis*	Tree/s	32	23	6			
13	*Acacia bussei*	Tree	41	14	4	67	33	41
14	*Pterollobiumsteiitu* (Forsk) Brenan	Shrub	5	5	1			

No	Species	Life form	*Alage*			Free grazing 1		
			Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)
15	*Oxyrix quadripartite Deon*	Tree/s	23	9	23			
16	*Dodonaea angustifolia*	Shrubs	486	36	1			
17	*Manytenus senegalensis*		9	5	1			
18	*Astragalus atropilosulus*	Tree	14	5	1			
19	*Scleracaryabirrea*	Tree	5	5	1			
20	*Strychnoshennigsii*		5	5	1			
21	*Z.spina-christi (*L) Desf.		5	5	1			
22	*Gomphocarpusfruticosus* (L) Aitf.		218	55	15			
23	*Payettaoliyeriana*	shrub	14	5	1			
24	*Grewia mollis Jues*	Tree	64	9	4			
25	*Grewia bicolor*	Tree/s	50	23	6			
26	*Acacia asak*	Tree	105	23	8	267	67	112
27	*Cadia purpurea*	Tree	355	27	17			
28	*Leucas abysissinica*	Shrub	18	9	2			
29	*Justicia schimperana*	Shrub	27	5	2			
30	*Toddalia asiatica* (L) Lam.	Shrub	9	9	2			
31	*Olea europeae,*	Tree	46	14	4			

No	Species	Life form	*Alage*			Free grazing 1		
			Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)	Abundance (N/ha)	Frequency (%)	Dominance m^2/ha)
32	*Olea europaea sub sp.caspidate*	Tree	5	5	1			
33	*Prunus Africana*	Tree	5	5	1			
34	*Prumus african*		9	5	1			
35	*Brideliamicrantha*	Tree	91	9	5			
36	*Hibscus ponduriformis* Burmf.	Shrub	335	14	14			
37	*Oxygonumsinuatum*	Shrub	186	5	7			
	Total		3096	487	200	434	133	200

* Modified IVI, without dominance value

1.2.2 Abundance, frequency and modified importance value index of saplings of the woody stems in the three land uses in *Selam Bekalsi*

No	Species	Life form	*Kern Awulie*			Free grazing 2		
			Abundance (N/ha)	Frequency (%)	Modified *IVI	Abundance (N/ha)	Frequency (%)	Modified *IVI
1	*Gomphocarpusfruticosus (*L) Aitf.	Tree	13	5	7			
2	*Acacia bussei*	Tree	9	9	9			
3	*Acacia torilis* (F0rssk) Hayne	Tree	45	27	32	67	33	32
4	*Leucas abyssinica* Hochst ex .Benth	Tree	5	5	4			
5	*Acacia etbaica* Schweinf	Tree	104	45	62			
6	*Acacia seyal* (Furs) Vahl	Tree	45	50	46			
7	*Euphorbia candelabrum* Gmel	Tree	86	14	36			
8	*Acacia oerfota* by M.Thulim	Tree	5	5	4	933	100	168
	Total		314	159	200	1000	133	200

* Modified IVI, without dominance value

1.3.1 Abundance, frequency and modified importance value index of seedlings of the woody stems in the three land uses in *Selen Wuha*

No	Species	Life form	*Alage*			Free grazing 1		
			Abundance (N/ha)	Frequency (%)	Modified *IVI	Abundance (N/ha)	Frequency (%)	Modified *IVI
1	*Dichrostachyscinerea*(L) Wight&Arn	Tree	345	14	7			
3	*Cartissaedulis*	Tree/s	55	5	2			
4	*Pterollobiustellatum*(Forsk) Brenan	Shrub				113	33	14
5	*Acacia fortilisi*	Tree				113	33	14
6	*Segeretiathea(Osbeck) Mc.Johnston*		36	5	2			
7	*Kalenchoa spp* Gideon Smth Estrela Figueiredo Abrham	Tree	55	5	2			
8	*Verpris nobilis* Jenna K.Moran	Tree/s	91	9	4			
9	*Chlorophytumtetra phyllum*	Shrub	73	14	5			
10	*Terminalia brownie*	Tree	36	9	3			
11	*Grewia species*	Tree/s	18	5	2			
12	*Eucleaschimperi*	Tree/s	91	9	4			
13	*Rumex aervolus* Vahil	Shrub	18	5	2			
14	*Rhusnatalensis*	Tree/s	55	5	2			
15	*Opuntia ficusindica*	Shrub	181	5	3			
16	*Acacia bussei*	Tree	18	5	2	267	66	28
17	*Dodonaeaangustifolia*	Tree/s	673	36	17			
18	*Euphorbia abyssinica*	Tree	36	5	2			
19	*Balanitesaegyptiaca*	Tree	18	5	2			
20	*Sclera ayabirrea*	Tree	55	5	2			
21	*Gomphocarpusfruticosus* (L) Aitf.	Tree	1200	36	22	400	33	21
22	*Payetta oliveriana*	Shrub	727	5	8			
23	*Celtis africana*	Tree	1055	27	18			
24	*Grewia bicolor*	Tree	236	9	5			
25	*Acacia asak*	Tree	55	14	5	3200	100	110
26	*Acacia etbaica*	Tree				113	33	14

No	Species	Life form	*Alage*			Free grazing 1		
			Abundance (N/ha)	Frequency (%)	Modified *IVI	Abundance (N/ha)	Frequency (%)	Modified *IVI
27	*Cadia purpurea*	Tree	1000	14	13			
28	*Leucas abyssinica*	Shrub	400	27	12			
29	*Justici aschimperana*	Shrub	782	14	11			
30	*Olea europeae*	Tree	36	5	2			
31	*Prumus africana*	Tree	55	5	2			
32	*Brideliamicrantha*	Tree	527	14	9			
33	*Hibscus ponduriformis* Burmf.	Shrub	2709	27	33			
	Total		10654	341	200	4206	298	200

* Modified IVI, without dominance value

1.3.2 Abundance, frequency and modified importance value index of seedlings of the woody stems in the three land uses in *Selam Bekalsi*

No	Species	Life form	*Keren Awulie*			Free grazing 2		
			Abundance (N/ha)	Frequency (%)	Modified *IVI	Abundance (N/ha)	Frequency (%)	Modified *IVI
1	*Gompho carpus fruticosus* (L) Aitf.		182	18	17	667	33.3	44
2	*Acacia bussei*	Tree	36	5	4			
3	*Ficus palmata (*Forsk)	Tree	18	5	3			
4	*Leucas abyssinica*	Shrub	364	41	38			
5	*Acacia etbaica*	Tree	527	23	33			
6	*Acacia asak*	Tree	1455	68	94	133	100	20
7	*Acacia sieberiana*	Tree	145	9	11			
8	*Acacia oerfota*	Shrub				1200	100	96
9	*Rhus atalensis* Krauss					133	33.3	20
10	*Kalenchoe spp.*	Shrub				133	33.3	20
	Total		2727	168	200	2266.7	233.2	200

* Modified IVI, without dominance value

1.3.3 Abundance, frequency and modified importance value index of seedlings of the woody stems in the three land uses in *Lemat*

No	Species	Life form	*Keren Taeo*			Free grazing 3		
			Abundance (N/ha)	Frequency (%)	Modified *IVI	Abundance (N/ha)	Frequency (%)	Modified *IVI
1	*Clematis hirsuta* Fresen	Shrub	57	14	6			
2	*Acacia bussei*	Tree	114	29	12			
3	*Gomphocarpus fruticosus* (L) Aitf.		914	71	42			
4	*Leucas abyssinica*	Shrub	2171	86	69	266.7	33.3	16
5	*Acacia asak*	Tree	2628	71	71			
6	*Acacia oerfota*	Shrub				9867	100	124
7	*Sageretia thea* (Osbeck)Mc.JohnSton					1467	66.7	41
8	*Balanites aegyptica*	Tree				533.3	33.3	19
	Total		5885	271	200	12133.3	233.3	200

* Modified IVI, without dominance value

Appendix II: Questionnaires

Part one: Individual interview

I. House hold characteristics

1. Region_____ Zone_____ Woreda _____ *Kebele* _____

   Village _____*Gote* _____

2. Ethnicity of the household 1) Tigreway 2) Amhara 3) Oromo 4) other
3. Age of the household _____
4. Sex of the household _____
5. Education status of the household:

1) Can't read and write 2) elementary school 3) high school 4) vocational

6. Marital status of the household: 1) single 2) married 3) widowed 4) separate
7. Family size: 1) <32) 3-43) 5-74) 4-95) >10
8. Family type: 1) Male headed 2) female headed
9. Farm size: 1) no land 2) <0.5ha 3) 0.5-1ha 4) >1ha
10. What is your main economic activity?

1) Farming 2) livestock production 3) trade 4) forestry 5) other

11. Livestock size at this time.

No	Livestock Type	quantity	Remark
1	Cattle		
2	Oxen		
3	Sheep and goat		
4	Equine		
5	Other		

12. Is your production amount sufficient for household consumption throughout the year?

    A) Yes B) No

13. If no what other sources do you use to supplement the deficit?

Management of the communal forest

14. What is your initiation to protect the communal forest?
15. Is the conservation of animal and plants a good Thing?
    1) Yes 2) No
16. What changes have you observed since you know the place?
    1) Still intact 2) better than before 3) slightly disturbed 4)Heavily disturbed
17. What wild animals are found in the communal forest?
18. How are the wild animals appeared since the area is managed by the community?
    1) Increase 2) decrease 3) Other
19. What are the major causes for the disappearance of forests and trees around your locally?
20. Have you ever been involved in making suggestions or decisions towards forest management?
    1) Yes 2) No
21. If the answer for Q.20 is not why?
22. What amendments need to be made on the community by law?
23. Do you sell forest products?
    1) Yes 2) No
24. If yes, is there any problem in selling the forest products?
    1) Yes 2) No
25. Do you face shortage of grazing lands due to communal forest?
    1) Yes 2) No
26. If yes to Q.25, How do you manage then?
27. Do you collect fuel wood?
    1) Yes 2) No
28. If yes where do you collect?
29. If no what do you use for your source of energy?
30. Do you have shortage of fuel wood?
    1) Yes 2) No

Land tenure & Land use system

31. Who owns/has the right to use the trees found on the communal forest?
    1) Local community 3) agricultural office
    2) Local administration 4) all
32. Does the entire community have the right to graze in the communal forest?
    1) Yes 2) No

33. What should be the future ownership look like to protect and benefit from the site?
    1) It should continue like how it is owned by now
    2) It is better to divide and share for users
    3) It is better to be under the ministry of agriculture

VI. Attitude towards communal forest

34. Do you agree the communal forest manage by the local institution called "*Sera?*"
    1) Yes 2) No
35. If the answer is yes for Q.34, why?
36. Why you are member of the local institution (*Sera)*?
37. Do you agree that only oxen graze in the communal forest in summer season?
    1) Yes 2) No
38. Do you agree that the community forest manage communally?
    1) Yes 2) No
39. Do you want the communal forest to be expanded?
    1) Yes 2) No
40. If yes where?
41. If the answer for Q.39 is no why?
42. Who is responsible to set the community by laws?
    1) The leaders of the local institution
    2) The community
    3) Both
    4) The government
43. Did the community participate in the bylaw set up?
    1) Yes 2) No
44. Do you obey the rules?
    1) Yes 2) No
45. Do you agree with the penalty?
    1) Yes 2) No
46. If no why?
47. Who select the leaders of "*Sera*"?

1) *Keble's* leader 2) Government 3) Community 4) Other

Part two group Discussion

I. Institutional arrangement

1) When do you start the social organization called "*Sera"*?
2) What are your incentives or initiations to protect the forest?
3) What are the techniques used for grazing animals in the forest?
4) Do you have guards for the communal forest?
5) Was it necessary to have the site guard?
6) Is the guard paid for doing such practice?
7) If yes to Q.6 in what way is it paid for?
8) Who is paying the salary for the site guard?
9) If the payment is in kind what kind of payment is it given?
10) Does this community forest have cultural value to you?
11) How many household or individuals are under this organization?
12) How many *"Gotes* or Villages" are managing by this organization?
13) Do you have rules for exploiting and maintaining the communal forest? If yes explain.
14) How do you formulate the rules?
15) How do you monitor the rules?
16) How do you punish for the people who violate the rules?
17) How do you enforce them?
18) How can you resolve conflict over use resources?
19) Do you have authority to devise your own institutions?
20) Are people outside the community allowed to get benefit?
21) If the answer is yes, to Q.20 explain the arrangement?
22) Does rapid population increase have any impact on the benefit of the community?
23) What is the tenure history of the communal forest?

II. **Technical Aspects**

24) Do you know the boundary of the communal forest?
25) What kind of forest products are the users allowed to use?
26) What products are not allowed to use?
27) How much amount of products are allowed to collect explain in numbers of donkey loads?
28) What species are valuable tree species for you?
29) What kind of protection and maintenance do you do for the valuable trees?
30) Is there anything you do to avoid competition of no-valuable tree species?
31) How do you control or protect the forest/trees damaging agents like pests, insects, fauna, and fire?
32) Is there anything you do to propagate valuable tree (and other forest) species? If it yes what is that?

III. **Informal survey**

a) Do you have communal forest managed by the local community in you village?
b) Do you have a free grazing land which is adjacent to communal forests?
c) If the answer is yes for Q. b, do the communal forest and free grazing land have the same vegetation cover in the past?
d) Do the communal forest and free grazing land have defined boundary?
e) How is the local institution arranged to manage the communal forest?
f) Which *Gotes* or Villages are the users of the communal forest?
g) What is the number of the user's household heads?
h) What is the number of female and male household heads?
i) What is you institution to manage the communal forest